Attorney Docket No: 247394US6 YA

TITLE OF THE INVENTION

METHOD AND APPARATUS FOR IMPROVED FASTENING HARDWARE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and is related to U.S. Provisional Application Serial No. 60/442,591, filed on January 27, 2003. The contents of this application are incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] This invention relates to an improved component for a plasma processing system, and more particularly, to hardware fasteners for internal chamber parts in a plasma processing chamber.

Discussion of the Background

[0003] The fabrication of integrated circuits in the semiconductor industry typically employs plasma to create and assist surface chemistry within a plasma reactor necessary to remove material from and deposit material to a substrate. In general, plasma is formed within the plasma reactor under vacuum conditions by heating electrons to energies sufficient to sustain ionizing collisions with a supplied process gas. Moreover, the heated electrons can have energy sufficient to sustain dissociative collisions and, therefore, a specific set of gasses under predetermined conditions (e.g. chamber pressure, gas flow rate, etc.) are chosen to produce a population of charged species and chemically reactive species suitable to the particular process being performed within the chamber, e.g. etching processes where materials are removed from the substrate or deposition where materials are added to the substrate.

[0004] Although the formation of a population of charged species (ions, etc.) and chemically reactive species is necessary for performing the function of the plasma processing system (i.e. material etch, material deposition, etc.) at the substrate surface, other component surfaces on the interior of the plasma processing chamber are exposed to the physically and chemically active plasma and, in time, can erode. The erosion of exposed components in the plasma system can lead to a gradual degradation of the plasma processing performance and ultimately to complete failure of the system.

SUMMARY OF THE INVENTION

[0005] These and other problems are addressed by the present invention which provides an apparatus and method for attaching replaceable parts within a process chamber such that the need to clean the chamber is reduced.

[0006] A first aspect of the invention is a fastener with coated protected surfaces resistant to etching by a processing plasma.

[0007] A second aspect of the present invention is a method of fabricating plasma resistant fasteners such that the fasteners are machined in a single step.

[0008] A third aspect of the present invention is a method of fabricating plasma resistant fasteners such that the fasteners are machined in multiple steps.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The above-noted and other aspects of the present invention will become more apparent from a detailed description of preferred embodiments when read in conjunction with the drawings, wherein:

[0010] FIGs. 1A-1D are plan views of various types of fasteners illustrating exemplary recesses therein;

[0011] FIGs. 1E-1H are side views of the fasteners of FIGs. 1A-1D;

[0012] FIG. 2 is a cross-sectional view of a portion of one type of fastener showing a protective coating over a portion of the fastener;

[0013] FIG. 3 depicts a flow chart representing a method of fabricating a fastener according to one embodiment of the present invention;

[0014] FIG. 4 depicts a flow chart representing another method of fabricating a fastener according to the present invention wherein at least a portion of the fastener is anodized;

[0015] FIG. 5 depicts a flow chart representing another method of fabricating a fastener according to the present invention wherein at least a portion of the fastener is masked; and

[0016] FIG. 6 depicts a flow chart representing another method of fabricating a fastener according to the present invention in which multiple machining steps are used.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] FIGs. 1A-1D and 1E-1H depict plan and side views, respectively, of improved fasteners 10, 20, 30, and 40 with a protective barrier 50. The fasteners can have several different types of fastener heads 60, 70, 80, and 90, respectively . The fasteners can have several different types of mating sections 65, 75, 85, and 95, respectively. Fastener 10 has an elongate female recess 100 along a diameter of the fastener head 60. Fastener 20 has a square male shape 110 in the center of fastener head 70. Fastener 30 has a hexagonal male shape 120 in the center of fastener head 80. Lastly, fastener 40 has an oblong male shape 130 in the center of fastener head

90. Alternately, male shapes can be substituted for female recesses, and female recesses can be substituted for male shapes. In other embodiments, geometrical or non-geometrical shapes can be used for female recesses and/or male shapes.

[0018] FIGs. 2A and 2B identify detailed cross-sectional views of typical fasteners 200. In the illustrated embodiments, a protective barrier coating 210 can be seen applied to the head portion 220 of the fastener 200 (e.g., any one of fasteners 10, 20, 30, and 40). The protective barrier coating 210 of the fastener 200 is applied to substantially all of the surfaces normally exposed to plasma processing.

[0019] The protective barrier can comprise a compound including an oxide of aluminum such as Al_2O_3. The protective barrier coating 210 can also comprise at least one of a III-column (column III of the periodic table) and a Lanthanon element. Further, the III-column element comprises at least one of Cerium, Dysprosium, and Europium. In another aspect of the present invention, the compound forming the protective barrier comprises at least one of Y_2O_3, Sc_2O_3, Sc_2F_3, La_2O_3, CeO_2, Eu_2O_3, or DyO_3.

[0020] The protective barrier coating 210 of fastener 200 comprises a specified thickness, wherein the specified thickness can be either constant across any specified surface or variable over any specified surface. For example a variable thickness can occur at an internal corner 230 or an external corner 240 of the fastener 200. Furthermore, the protective barrier formed on the fastener comprises a specific tolerance, wherein the specified tolerance can be specified as constant across any one surface and variable across any other surface. Preferably, the thickness of the protective barrier coating ranges from about 50 micron to about 500 micron, more preferably, the specified thickness of the protective barrier coating ranges from about 100 micron to about 200 micron; and most preferably, the specified thickness of the protective barrier coating comprises 200 micron. Preferably, the thickness tolerance comprises plus or minus

50 micron. Therefore, the achieved thickness ranges from 0 micron to 550 micron; more preferably the achieved thickness ranges from 150 micron to 250 micron.

[0021] FIG. 3 represents a method of fabricating a fastener for a plasma processing system. A flow diagram 300 begins with a machining operation step 310 that produces a fastener with a threaded shank portion and a head portion. The fastener can be machined according to specifications set forth on a mechanical drawing using conventional techniques for machining components that are well known to those skilled in the art of machining. The fastener can, for example, be fabricated from A6061 aluminum. After machining and cleaning of the fastener, surfaces of the fastener exposed to plasma processing are coated with a protective barrier in a coating step. Such a coating step can, for example, be a spray coating step.

[0022] FIG. 4 depicts a flowchart 400 representing another method of fabricating a plasma resistant fastener according to the present invention. In the flow diagram 400, the fastener is again first machined and cleaned in a machining step 310. Next, the fastener goes through an anodization step 410 wherein the entire fastener is anodized to form a surface anodization layer. For example, when fabricating the fastener from aluminum, the surface layer comprises aluminum oxide (Al_2O_3). Methods of anodizing aluminum components are well known to those skilled in the art of surface anodization. After the anodization process, surfaces of the fastener exposed to plasma processing are coated with a protective barrier in the coating step 320 as described above.

[0023] FIG. 5 presents another method of fabricating a plasma resistant fastener according to the present invention. In flow diagram 500, the fastener undergoes the step 310 of machining and cleaning using techniques described above. Next, in a masking step 510, a set of surfaces on the fastener is masked to prevent the formation of an anodization layer. The fastener then goes through an anodization step 410 such that the unmasked surfaces are anodized to form a surface anodization layer. After the anodization process, surfaces of the fastener exposed to a plasma proceSs that have been anodized are coated with a protective barrier in the coating step 320 as described above. Finally, in a masking removal step 520, the masking material is removed from the fastener. It should be noted that not all unmasked (or anodized) surfaces need to be later coated with a protective coating. Some surfaces, for example, may be designed to remain bare (i.e., free from the anodization layer) in order to achieve a better contact with a mating surface on another component.

[0024] FIG. 6 presents another method of fabricating a plasma resistant fastener according to the present invention. In the flow diagram 600, the fastener is partially machined in a partial machining step 610. Next the partially completed fastener is anodized on all surfaces in an anodization step 410 as described above. Next the fastener is machined in a machining completion step 620 to provide the remaining features needed to complete the hardware. Finally, surfaces of the fastener that are exposed to plasma processing are coated in a coating step 320 as described above. In an alternate embodiment, steps 620 and 320 in FIG. 6 can be reversed.